

We Claim:

1. A device for monitoring activity of carbon in a heat treating atmosphere comprising
5 a processor to generate a computed activity of carbon value for the gas atmosphere as a function of temperature, partial pressure of oxygen, and carbon monoxide content of the gas atmosphere, and without determining a carbon dioxide content of the gas atmosphere, and
10 an output terminal coupled to the processor to output the computed activity of carbon value.
2. A device according to claim 1
15 wherein the processor includes a comparator to compare the computed activity of carbon value to a selected set point and generate a deviation, and further including an output for the deviation.
3. A device according to claim 2
20 wherein the output is coupled to a controller for the atmosphere.
4. A device according to claim 2 or 3
25 and further including an input for recording the selected set point from an operator.
5. A device according to claim 1
30 wherein the output is coupled to a device for displaying the computed activity of carbon value.
6. A device according to claim 1
35 wherein the output is coupled to a device for recording the computed activity of carbon value.
7. A device according to claim 1
and further including an input adapted to receive an electrical signal generated by at least one sensor indicating either the partial pressure of oxygen or the temperature of the atmosphere, and
wherein the processor processes the electrical signal to generate the computed activity of carbon value.

8. A device according to claim 1
and further including an input adapted to be
coupled to a temperature sensor that generates an
electrical signal that varies according to the
temperature of the atmosphere, and
wherein the processor processes the electrical
signal to generate the computed activity of carbon value.
9. A device according to claim 1
and further including an input adapted to be
coupled to an oxygen sensor that generates an electrical
signal that varies according to the temperature and
partial pressure of oxygen of the atmosphere, and
wherein the processor processes the electrical
signal to generate the computed activity of carbon value.
10. A device according to claim 1
wherein the processor also generates an
oxidation alarm based upon the partial pressure of oxygen
and temperature of the gas atmosphere.
11. A device according to claim 1
and further including an input coupled to the
processor and adapted to receive an electrical signal
that varies according to the carbon monoxide content of
the gas atmosphere, and
wherein the processor processes the electrical
signals to generate the computed activity of carbon
value.
12. A device according to claim 11
wherein the electrical signal is generated
based upon analysis of a gas atmosphere sample.
13. A device according to claim 11
wherein the electrical signal is set based
upon a known carbon monoxide content.
14. A system for monitoring a gas heat
treating atmosphere comprising
a processing element to derive a process

variable indicative of an activity of carbon value for the gas atmosphere derived from at least one sensor placed *in situ* in the gas atmosphere, and

an output for the process variable.

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15. A system according to claim 14

wherein the output is coupled to a device that displays the process variable.

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16. A system according to claim 14

wherein the output is coupled to a device that records the process variable.

17. A system according to claim 14
wherein the output is coupled to a device that generates the gas atmosphere.

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18. A spherodize annealing system comprising a heat treating furnace,

an atmosphere source for supplying a preselected gas atmosphere to the furnace,

a heat source to maintain the preselected gas atmosphere inside the furnace at a preselected 20 temperature,

an oxygen sensor located *in situ* in the furnace in contact with the preselected gas atmosphere, the oxygen sensor providing a first electrical input that varies according to oxygen content of the preselected atmosphere,

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a temperature sensor located *in situ* in the furnace in contact with the preselected gas atmosphere, the temperature sensor providing a second electrical input that varies according to temperature of the preselected atmosphere,

a processor to generate a computed activity of carbon value for the preselected atmosphere as a function of the first and second electrical inputs.

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19. A system according to claim 18

and further including an output for the

computed activity of carbon value.

20. A system according to claim 19
wherein the output is coupled to a device for
displaying the computed activity of carbon value.

5 21. A system according to claim 19
wherein the output is coupled to a device for
recording the computed activity of carbon value.

10 22. A system according to claim 19
wherein the output is coupled to a controller
for the atmosphere source.

23. A system according to claim 18
wherein the processor includes a comparator to
compare the computed activity of carbon value to a
selected set point and generate a deviation, and
15 further including an output for the deviation.

24. A system according to claim 23
wherein the output is coupled to a controller
for the atmosphere source.

20 25. A spherodize annealing system comprising
a heat treating furnace,
an atmosphere source for generating a
preselected gas atmosphere and supplying the preselected
gas atmosphere to the furnace,

25 a heat source to heat the preselected gas
atmosphere sufficiently to create a two phase region
inside the furnace,

30 a processor to generate a computed activity of
carbon value for the gas atmosphere as a function of
temperature, partial pressure of oxygen, and carbon
monoxide content of the gas atmosphere, and without
determining a carbon dioxide content of the gas
atmosphere,

35 an output terminal coupled to the processor to
output the computed activity of carbon value, and

a controller coupled to the output terminal

and the atmosphere source to control generation of the gas atmosphere according to the computed activity of carbon value.

26. A system according to claim 25
5 wherein the processor includes a comparator to compare the computed activity of carbon output to a set point value and generate a control signal based upon the comparison,

10 wherein the output terminal outputs the control signal to the controller, and

wherein the controller controls generation of the gas atmosphere based upon the control signal.

27. A system according to claim 25
15 wherein the selected activity of carbon value varies as a function of temperature.

28. A method for monitoring a heat treating atmosphere comprising the steps of

20 generating a computed activity of carbon value of the heat treating atmosphere as a function of temperature, partial pressure of oxygen, and carbon monoxide content of the heat treating atmosphere, and without determining a carbon dioxide content of the heat treating atmosphere, and

25 using the computed activity of carbon value.

29. A method according to claim 28
wherein the using step includes controlling the heat treating atmosphere based, at least in part, upon the computed activity of carbon value.

30. A method according to claim 29
30 wherein the using step includes recording the computed activity of carbon value.

31. A method according to claim 29
wherein the using step includes displaying the computed activity of carbon value.

35 32. A method for monitoring a heat treating

atmosphere comprising the steps of
5 deriving from at least one sensor placed in
situ in the heat treating atmosphere a process variable
indicative of the activity of carbon in the heat treating
atmosphere, and
10 using the process variable.
33. A method according to claim 32
wherein the using step includes controlling
the heat treating atmosphere based, at least in part,
15 upon the process variable.
34. A method according to claim 32
wherein the using step includes recording the
process variable.
35. A method according to claim 32
15 wherein the using step includes displaying the
process variable.
36. A method for performing spherodize
annealing comprising the steps of
20 generating a gas atmosphere and supplying the
gas atmosphere to a furnace,
heating the gas atmosphere in the furnace
sufficiently to create a two phase region,
generating a computed activity of carbon value
25 for the gas atmosphere as a function of temperature,
partial pressure of oxygen, and carbon monoxide content
of the gas atmosphere, and without determining a carbon
dioxide content of the gas atmosphere, and
controlling the gas atmosphere according to
the computed activity of carbon value.
30 37. A method according to claim 36
and further including the step of comparing
the computed activity of carbon output to a selected
activity of carbon value and generate a control signal
based upon the comparison, and
35 wherein control step controls the gas

atmosphere based upon the control signal.

38. A method according to claim 37
wherein the selected activity of carbon value
varies as a function of temperature.

5 39. A method for performing spherodize
annealing comprising the steps of

generating a gas atmosphere and supplying the
gas atmosphere to a furnace,

10 heating the gas atmosphere in the furnace
sufficiently to create a two phase region,

sensing oxygen content with an oxygen sensor
placed in situ in the furnace to provide a first
electrical output that varies according to oxygen content
of the gas atmosphere,

15 sensing temperature with a temperature sensor
placed in situ in the furnace to provide a second
electrical output that varies with temperature,

computing an activity of carbon value based
upon the first and second electrical outputs, and

20 controlling the gas atmosphere according to
the computed activity of carbon value.

40. A method according to claim 39

and further including the step of comparing
25 the computed activity of carbon to a selected activity of
carbon value and generate a control signal based upon the
comparison, and

wherein control step controls the gas
atmosphere based upon the control signal.

41. A method according to claim 40

30 wherein the selected activity of carbon value
varies as a function of temperature.

42. A method for determining a partial
pressure of carbon monoxide in a gas atmosphere
comprising a mixture of nitrogen and either an
35 endothermic atmosphere or methanol, the method comprising

the steps of

supplying the gas atmosphere at a fixed flow rate into a furnace,

5 deriving from an oxygen sensor placed in situ in the furnace a sensed partial pressure of oxygen in the furnace,

deriving from a temperature sensor placed in situ in the furnace a sensed temperature in the furnace,

10 deriving, without using a carbon monoxide sensor outside the furnace, a partial pressure of carbon monoxide as a function of the sensed partial pressure of oxygen and the sensed temperature.